§6. Edge Pedestal Structure Measured with CXS at a Horizontally Elongated Cross Section

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A main improvement of the ETB plasmas can be seen in the particle confinement [1], and the increase of electron and ion temperatures was not always clear [2]. This is a contrastive characteristic of ETB compared with the N-ITB plasmas [2]. Another important question still remained on plasma rotations and/or radial electric fields in ETB plasmas. In contrast to tokamak H-mode plasmas, the plasma rotation in the core region in ETB plasmas is slower [2]. However, the radial electric field and/or the rotations of ions are connected to the ion pressure gradient by the radial force balance, and therefore the steep density gradient at the edge region in the H phase will make some changes of the electric fields and/or the ion rotations. For collisional plasmas, the neoclassical theory for non-symmetric toroidal systems predicts the negative radial electric fields determined by the ion pressure gradients [3], and therefore a role of the ion pressure gradients [4] is a theme to be studied in helical systems. From various edge plasma measurements in ETB plasmas, it is suggested that the edge pedestal region, where the ion pressure gradients and corresponding ion rotation are expected, is very narrow (for e.g., $\Delta\rho\approx0.05$) if it exists. Detections of the rotations and the ion temperature profile in the narrow region are impossible with previous charge exchange spectroscopy (CXS) at a vertically elongated section [2] with the chord spacing ΔR=7.5mm corresponding to a spatial resolution of $\Delta\rho\approx0.06$. To improve this spatial resolution, we carried out the CXS at a horizontally elongated cross section. The chord spacing ΔR=6.3mm at the equatorial plane Z=0 corresponds to a spatial resolution of $\Delta\rho\approx0.02$. Figure 1 shows results in an ETB plasma in a configuration with a magnetic axis position of $R_{\rm ax}$=92.1cm, a quadrapole magnetic field of $B_{\rm q}$=0, and a magnetic field strength of $B_{\rm t}$=0.9T. The line averaged electron density is controlled to keep a slow raise up to $5\times10^{13}\,{\rm cm}^{-3}$. The ion temperature has a pedestal structure of $\Delta T_{\rm i}\approx100$eV at the edge and does not show clear changes at the L/H transition timing t=80ms. It is consistent with previous measurements at the vertically elongated section indicating that the edge temperature is about $T_{\rm i}\approx100$eV and do not change at the transition [2]. However, the plasma density in this region is being increased in this transition phase, and thus the ion pressure gradient also grows. The Doppler shift indicating the edge poloidal rotation of fully ionized carbon ions (C^{6+}) in a direction of the electron diamagnetic drift shows a change corresponding to this growth. Here, it should be noted that this velocity of impurity ions is dominated by the E×B drift [5], and that the observed values are large in spite of a fact that the potential gradient $\partial\phi/\partial R$ at the horizontally elongated sections is smaller than that in the vertically elongated sections. The electric field strength seems to be saturated at $E_r\approx-10$kV/m in the H phase. This electric field strength at the region of $T_{\rm i}\le100$eV may be enough in viewpoint of the poloidal Mach number and will be an important key in considering the transition mechanisms. In contrast to the N-ITB plasmas with the ion temperature pedestal of $\Delta T_{\rm i}\approx100$eV and $\Delta\rho$=0.3 at the E_r shear region with $E_r\approx+20$kV/m [2], the edge ion temperature pedestal region with the relatively large poloidal rotation seems to be narrow ($\Delta\rho\le0.1$) in the ETB plasmas. This width may be one key to understand the difference between N-ITB and ETB plasmas. As mentioned above, the time evolution of the edge electron density is important to understand these results, more detailed analyses of results of the edge density measurements using LiBP[6] are planned in FY2006.

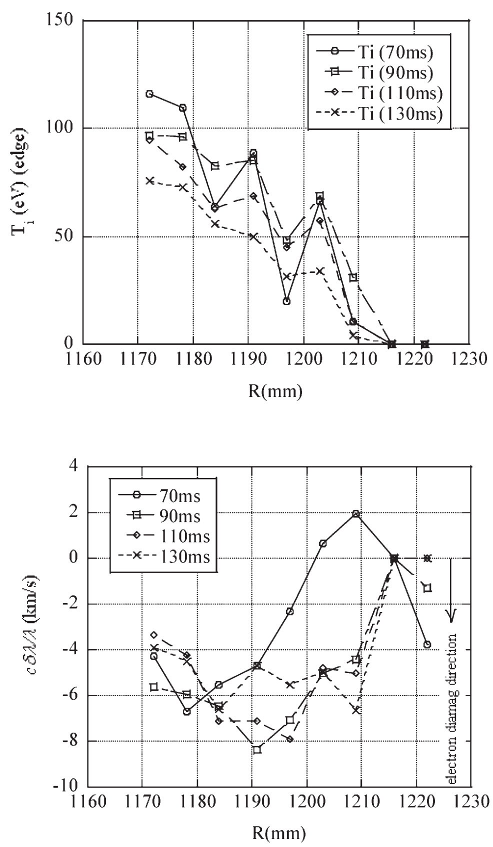

Figure 1 The ion temperature $T_{\rm i}$ and the Doppler shift $\delta\lambda$ of the charge exchange excited CVI line(λ=529nm) observed near the LCFS at $R\cong1.2$m. The L/H transition occurred at t=80ms.

References

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